

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application for LETTERS PATENT

for

MODULAR MONOLITHIC BULKHEAD PANEL

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MODULAR MONOLITHIC BULKHEAD PANEL

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority from provisional application serial No. 60/276,563, filed March 14, 2001.

BACKGROUND OF THE INVENTION

Technical Field

[0002] The present invention relates to panel structures and more particularly to panel structures of the type used in aircraft bulkheads.

[0003] Compartment Bulkheads used on modern airplanes are designed utilizing non-metallic composite hybrid thermosetting phenolic resin sandwich panels that can be peripherally framed or not depending on the space and design requirements unique to each bulkhead location. Framed panels are used in areas where aircraft structures do not allow sufficient edge margin space typically required for non-framed monolithic composite panels. Framed panels are also used in areas where extreme heat resistance and low smoke vapor toxicity emissions are required, or where the panel will be frequently removed in service - such as a maintenance access cover, and where fastener hole wear resistance is required. Finally monolithic framing is used to prevent face sheets from delaminating from the composite panel core resulting from in service abuse. The modular nature of this built up structure has been attractive because it allows designers the flexibility of tailoring the composition of the panels to particular design requirements - such as high temperature, strength, noise attenuation as well as saving weight.

Background Art

[0004] Exemplary of prior art panel structures utilized in aircraft is U.S. Patent No. 4,557,961 to Gorges issued December 10, 1985 and assigned to The Boeing Company.

[0005] The state of the art metal-framed panel designs are labor intensively built up from multiple details which include machined parts, stretch formed parts, profiled extrusions, blanked sheet metal parts, non-metallic subassemblies and associated standards. Fabrication of the panel assemblies usually requires large tools to hold the panel periphery while the assembly of the panels is completed so that the edge margin alignment is maintained. Splice plates or integrated overlaps are required to attach one segment of the frame to another and all of these frame splices are completed using fasteners. All existing designs usually require a post assembly drilling operation utilizing drill templates or numerical control programs in efforts to provide controlled fastener patterns. Once the frames have been assembled additional labor intensive operations are required to seal and finish the panel, i.e., masking, local trimming, local primer touch up, enamel application, silicon sealing and the application of adhesive backed silicon foam seals.

BREIF SUMMARY OF THE INVENTION

[0006] Disclosed is a modular monolithic cost-effective metal-framed bulkhead panel design. According to one aspect of the invention, the novel assembly reduces part count. According to another aspect of the invention, the novel assembly eliminates hard tooling requirements. According to yet another aspect of the invention, the novel assembly reduces fabrication time and reduces inventory requirements. According to still another aspect of the invention, the novel assembly allows for easy replacement of any component of this assembly that is damaged during handling or use. According to still yet another aspect of the invention, the novel assembly provides a robust reliable design by preventing the face sheets from delaminating from the honeycomb core resulting from in service abuse. The present monolithic bulkhead panel providing the above

features and advantages utilizes a unique combination of only five basic components hereinafter described in detail.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

[0007] The above features and advantages of the present invention will become more readily apparent upon reading the following detailed description and upon reference to the attached drawings in which:

[0008] Figure 1 is an exploded view of the state of the art panel design used in prior art;

[0009] Figure 2 is exemplary of the prior art multiple part panel design;

[0010] Figure 3 is an exploded view of a modular monolithic panel embodying the present invention;

[0011] Figure 4 is exemplary of a modular monolithic panel in accordance with the present invention; and

[0012] Figure 5 is a perspective view of a preferred embodiment of the present invention in the compartment bulkhead structure of an aircraft.

DETAILED DESCRIPTION OF THE INVENTION

[0013] Turning now to the drawings, there is shown in Figs. 1 and 2 a prior art metal-framed panel structure of multiple part design.

[0014] Turning now to Figs. 3 and 4 of the drawings, like numerals being used for like and corresponding parts of the various drawings, it will be seen that a robust

modular monolithic cost effective bulkhead panel design is seen which eliminates labor intensive assembly process, reduces part count, reduces fabrication costs and reduces inventory requirements. The present monolithic bulkhead panel design provides that fabrication and final protective finishes can be incorporated at the detail level and the assembly of the present monolithic panel can be accomplished on the bench with standard hand tools utilizing standard hardware and adhesive backed seals. This design approach greatly reduces reoccurring assembly labor. The detail part count for a panel assembly is reduced over the prior art designs in an effort to reduce fabrication time and lower the associated inventory cost. Components of the assembly can easily be replaced should they become damaged during handling or use.

[0015] The present monolithic bulkhead panel comprises five basic components as seen in Fig. 3: 1) Machined metal frame 1 gauged in support of fire worthiness directives addressing metal degradation (with nutplates), 2) machined metal internal ring 4 with nutplates), 3) non-metallic hybrid composite panel subassembly 3 with potted inserts, 4) adhesive backed silicone foam internal seal (one seal or multiple interlocking seals); and 5) one frame seal (one seal or multiple interlocking seals) common to the panel structure interface. Machined metal frame 1 is machined from aluminum plate that is complete with all of the required hardware and final finishes. Inner ring 4 is machined from aluminum plate and comes the required hardware and final finishes. Ring 4 contains integral panel indexing features as seen in Fig. 4 that insures alignment of the non-metallic hybrid composite panel during the assembly process. A non-metallic hybrid composite panel mislocation could compromise the resilience to fire and smoke propagation effects. The non-metallic panel subassembly is complete with floating potted inserts, which aid in the assembly process. The adhesive backed silicon foam seals as seen in section A-A of Fig. 4 are peripherally precut to support simple application by the fabrication center mechanics. The entire assembly can be bolted together by fabrication personnel utilizing standard fasteners and hand tools.

[0016] The method of assembly of the present modular monolithic bulkhead panel includes the steps of utilizing a first metal frame for holding the present composite panel

and then utilizing a second metal frame for retaining the composite panel in the first metal frame. A gasket is utilized for sealing the joint between the composite panel and the first and second frames, the gasket being inserted into the first metal frame. The composite panel is then inserted into the gasket and first metal frame subassembly. The second frame is then inserted into the subassembly and the first and second metal frames are then joined.

[0017] Figure 5 is illustrative of the present modular monolithic panel shown in the compartment bulkhead structure of an aircraft.

[0018] A composite panel which utilizes any combination of graphite, a carbon fiber reinforced plastic material; Kevlar, an aramid fiber prepreg material; or fiberglass, a glass reinforced plastic material is referred to hereinabove as the hybrid composite panel.